CLAIMS

1.   An encoding data processing apparatus for generating at least one version of an original item of material formed by combining one of a predetermined set of code words into a copy of the original material item, the apparatus comprising

5   a bandwidth adaptation processor operable to adapt a bandwidth of the code word with respect to the bandwidth of the original material item, and

an encoder operable to combine the bandwidth adapted code word with a copy of the original material item, with an effect that the code word is combined with part of the bandwidth of the material item.

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2.   An encoding data processing apparatus as claimed in Claim 1, wherein the bandwidth adaptation processor is operable to increase the bandwidth of the code word in accordance with a ratio of a reduced-bandwidth-version of the material item to the part of the bandwidth of the material item with which the code word is to be

15   combined.

3.   An encoding data processing apparatus as claimed in Claim 1, wherein the bandwidth increase provided by the bandwidth adaptation processor is made in at least one of temporal or spatial domains.

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4.   An encoding data processing apparatus as claimed in Claim 1, wherein the bandwidth adaptation processor comprises first and second adaptation processors,

the first adaptation processor being operable to increase the bandwidth of the code word in accordance with at least one of the temporal or spatial domains, and

25   the second adaptation processor being operable to form a reduced-bandwidth-version of the original material item, the bandwidth reduction being at least one of temporally or spatially effected and in accordance with the increase to the code word bandwidth by the first adaptation processor, wherein the encoder is operable to adapt coefficients of the code word with respect to the samples of the reduced-bandwidth-

30   version of the material item to which the code word coefficients are to be combined, the adaptation of the code word coefficients with respect to the reduced-bandwidth-

version being made to the effect of reducing a likelihood of the code word being perceivable in the marked representation of the material item.

5.   An encoding data processing apparatus as claimed in Claim 4, wherein the first adaptation processor includes

a temporal up-sampler operable to introduce samples into the code word in accordance with an increased sampling rate, and

a low-pass filter operable to filter the up-sampled code word, wherein a bandwidth of the low-pass filter and the up-sampling rate has an effect of increasing the bandwidth of the code word with respect to the bandwidth corresponding to the original material item.

6.   An encoding data processing apparatus as claimed in Claim 4, wherein the first adaptation processor comprises

a spatial up-sampler operable to convert the bandwidth of the code word substantially to the spatial bandwidth of the original material item.

7.   An encoding data processing apparatus as claimed in Claim 6, wherein the spatial up-sampler operates to form the code word into a sub-band representing a wavelet transform sub-band and to perform an inverse wavelet transform on a set of sub-bands corresponding to a wavelet transform of the spatial bandwidth of the original material item, the other sub-bands being set to zero.

8.   An encoding data processing apparatus as claimed in Claim 4, wherein the second adaptation processor includes

a temporal sub-sampler operable to form the reduced-bandwidth-version of the material item.

9.   An encoding data processing apparatus as claimed in Claim 8, wherein the temporal sub-sampler comprises a low-pass filter in combination with a sample selector operable to selectively sample the material item after low-pass filtering.

10.   An encoding data processing apparatus as claimed in Claim 4, wherein the second adaptation processor includes

a spatial sub-sampler operable to form the reduced-bandwidth-version of the material item.

11.   An encoding data processing apparatus as claimed in Claim 10, wherein the spatial sub-sampler comprises a wavelet transform processor operable to form a wavelet transform of the material item and a sample selector operable to select one of a plurality of sub-bands of the wavelet transform to form the reduced-bandwidth-version of the material item.

12.   An encoding data processing apparatus as claimed in Claim 1, comprising a code word generator operable to generate the code word using a pseudo-random number generator initialised with a seed value uniquely associated with the code word, the code word coefficients being formed from numbers generated by the pseudo-random number generator.

13.   An encoding data processing apparatus as claimed in Claim 12, comprising

a discrete cosine transform processor operable to transform the original material item into the discrete cosine transform domain, the material item in the discrete cosine transform domain being represented as a plurality of discrete cosine transform coefficients, wherein the encoder is operable to combine the bandwidth adapted code word with the material item by adding each of the adapted code word coefficients to a corresponding one of the discrete cosine transform coefficients, and

an inverse discrete cosine transform processor operable to form the marked version of the material item by performing an inverse discrete cosine transform on the discrete cosine transformed material item to which the code word has been added by the encoder.

14.   A detecting data processing apparatus operable to determine whether one or more code words of a predetermined set of code words is present in a suspected

version of a material item, the suspected version having been assumed to have been formed by combining a code word with part of the bandwidth of the original material item, said apparatus comprising

a bandwidth processor operable

5   to form a reduced-bandwidth-version of a copy of the original material item and a reduced-bandwidth-version of the suspected version of the material, or a reduced-bandwidth-version of a difference between the original and suspect material items, the bandwidth reduction being arranged to isolate the part of the bandwidth of the material to which the code word may have been combined,

10   a recovery processor operable to generate a recovered code word from the reduced-bandwidth-versions of the original and suspect material items or reduced-bandwidth-version difference between the suspect and original material items,

a correlation processor operable to generate, for each of the code words in the predetermined set of code words a correlation value by correlating the recovered code

15   word with each of the generated code words, and

a detection processor operable to detect one or more code words from the correlation value for the code word exceeding a predetermined threshold.

15.   A detecting data processing apparatus as claimed in Claim 14,

20   comprising

a registering processor operable to associate samples of the original material item and the suspect version of the material item to which corresponding code word coefficients may have been combined, the registration processor being operable in combination with the bandwidth adaptation processor to perform the association as

25   part of the bandwidth reduction.

16.   A detecting data processing apparatus as claimed in Claim 14, wherein the code word has been introduced into the bandwidth of the suspect material item at least one of temporally or spatially and correspondingly the bandwidth adaptation

30   processor is operable to perform the bandwidth reduction at least one of temporally or spatially.

17.   A detecting data processing apparatus as claimed in Claim 14, wherein the correlation processor includes a code word generator operable to generate pseudo-random numbers from which said regenerated code word coefficients are formed, the pseudo-random numbers being generated from a seed value uniquely associated with said code word.

18.   A detecting data processing apparatus as claimed in Claim 17, wherein the seed value is formed from the samples of the marked material item.

19.   A detecting data processing apparatus as claimed in Claim 14, wherein the code word has been introduced into the material item in the discrete cosine transform domain, the apparatus comprising

a discrete cosine transform processor operable to transform the suspected reduced-bandwidth-version of the material item and the reduced-bandwidth-copy of the original material item into the discrete cosine transform domain, wherein the recovery processor is operable to generate the recovered code word by subtracting corresponding discrete cosine transform coefficients of the original material version from discrete cosine transform coefficients of the marked material version.

20.   A system for identifying the recipient of a material item, the system comprising

an encoding data processing apparatus according to Claim 1, and

a detecting data processor according to Claim 14, operable to detect with a predetermined false positive probability the recipient by detecting the presence or absence of the code word in the material.

21.   A method of generating at least one version of an original item of material, formed by introducing one of a predetermined set of code words into a copy of the original material item, the method comprising

adapting a bandwidth of the code word with respect to a bandwidth of the original material item, and

combining the bandwidth adapted code word with a copy of the original material item, with an effect that the code word is combined with part of the bandwidth of the material item.

22.   A method as claimed in Claim 21, wherein the adapting the bandwidth is increasing the bandwidth of the code word in accordance with a ratio of a reduced-bandwidth-version of the material item to the bandwidth of the material item or part thereof with which the code word is to be combined.

23.   A method of determining whether one or more code words of a predetermined set of code words is present in a suspected version of a material item, the suspected version having been assumed to have been formed by combining a code word having a lower-bandwidth with respect to the bandwidth of the original material item, the method comprising

forming a reduced-bandwidth-version of a copy of the original material item and a reduced-bandwidth-version of the suspected version of the material, or a reduced-bandwidth-version of a difference between the original and suspect material items, the bandwidth reduction being arranged to isolate the part of the bandwidth of the material to which the code word may have been combined,

generating a recovered code word from the reduced-bandwidth-versions of the original and suspect material items or reduced-bandwidth-version difference between the suspect and original material items,

generating for each of the code words in the predetermined set of code words a correlation value by correlating the recovered code word with each of the generated code words, and

detecting one or more code words from the correlation value for the code word exceeding a predetermined threshold.

24.   A data signal representing a material item to which a code word has been added, as produced by the data processing apparatus according to Claim 1.

25.   A data carrier having recorded thereon a data signal according to Claim 24.

26.   A computer program providing computer executable instructions, which when loaded onto a data processor configures the data processor to operate as an encoding data processing apparatus according to Claim 1.

27.   A computer program providing computer executable instructions, which when loaded onto a data processor configures the data processor to operate as a detecting data processor according to Claim 14.

28.   A computer program providing computer executable instructions, which when loaded on to a data processor causes the data processor to perform the method according to Claim 21.

29.   A computer program product having a computer readable medium having recorded thereon information signals representative of the computer program claimed in Claim 26.

30.   A computer program product having a computer readable medium having recorded thereon information signals representative of the computer program claimed in Claim 27.

31.   A computer program product having a computer readable medium having recorded thereon information signals representative of the computer program claimed in Claim 28.

32.   An apparatus for generating at least one version of an original item of material, formed by introducing one of a predetermined set of code words into a copy of the original material item, the apparatus comprising

means for adapting a bandwidth of the code word with respect to a bandwidth of the original material item, and

means for combining the bandwidth adapted code word with a copy of the original material item, with an effect that the code word is combined with part of the bandwidth of the material item.

33.   An apparatus as claimed in Claim 32, wherein the means for adapting the bandwidth is operable to increase the bandwidth of the code word in accordance with a ratio of a reduced-bandwidth-version of the material item to the bandwidth of the material item or part thereof with which the code word is to be combined.

34.   An apparatus for determining whether one or more code words of a predetermined set of code words is present in a suspected version of a material item, the suspected version having been assumed to have been formed by combining a code word having a lower-bandwidth with respect to the bandwidth of the original material item, the apparatus comprising

means for forming a reduced-bandwidth-version of a copy of the original material item and a reduced-bandwidth-version of the suspected version of the material, or a reduced-bandwidth-version of a difference between the original and suspect material items, the bandwidth reduction being arranged to isolate the part of the bandwidth of the material to which the code word may have been combined,

means for generating a recovered code word from the reduced-bandwidth-versions of the original and suspect material items or reduced-bandwidth-version difference between the suspect and original material items,

means for generating for each of the code words in the predetermined set of code words a correlation value by correlating the recovered code word with each of the generated code words, and

means for detecting one or more code words from the correlation value for the code word exceeding a predetermined threshold.